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ALTERNATING CURRENTS

THE story of a pioneer in alternating currents of electricity was told at Vancouver, B. C., at the convention of the American Institute of Electrical Engineers by the pioneer himself, Dr. Frederick Bedell, now consulting physicist of Pasadena, Calif.

The present occasion is the fiftieth anniversary of the first paper presented to the institute by Dr. Bedell and his collaborator, A. C. Crehore, on alternating currents, which cleared up for the first time misunderstandings and confusions in this field. It has been called a "pioneer paper" and "a classic in its field."

Dr. Bedell is the inventor of oscilloscope with linear time axis, which pictures the alternating current wave form on a fluorescent screen. It is now an indispensable instrument in every field including telephony and television where alternating, fluctuating or transient currents are involved. His pioneer research and inventions in bone conduction have enabled many people to hear who never heard before.

For these two outstanding achievements, Dr. Bedell was honored in 1940 with the award of Modern Pioneer on the American Frontier of Industry by the National Association of Manufacturers. "In 1890," Dr. Bedell said, "alternating current was just plain freak; it did not follow Ohm's law and 'clogged' itself in its circuits." Nobody understood it. Everyone was afraid of it.

The first installation in 1886 put 500 volts on the transmission line and then stepped it down to 100 volts by the then newly-born transformer. The length of the line was 4,000 feet. But electricians said, according to Dr. Bedell, "If a high potential primary circuit of 500 volts or more were used to distribute electricity throughout a community, there was grave fire and life danger." A few years later a bill was introduced in the Virginia legislature to limit alternating current voltage to 200, alternating current being considered more deadly than direct. This is a far cry, Dr. Bedell remarked, from the 287,500 volts of the Boulder Dam plant of to-day.

The chief worry of engineers in the early nineties was wave form "whatever that might be." They knew from the principles of sound that a pure tone is given by a "sine" wave, that any departure from this form means the presence of harmonics which may have 2, 3, 4, or many more times the frequency of the fundamental note. Such harmonics in an alternating current wave could be dangerous, for the inductive effects increase with the frequency. If the circuit happens to be in tune with any one of them, the voltage may reach very high peaks and fireworks on the switchboard may result—and often did.

But what is a tuned circuit? Why is the current "clogged" in some circuits, while the voltage jumps to distressing heights in others? The answers to these and many other questions were given in the 1892 paper of Bedell and Crehore. Its 72 pages contained the first clear and mathematically correct theory of the flow of alternating currents both in transient as well as in steady conditions. Vector methods and circle diagrams, now so common, were introduced, and the first use was made of complex quantities. Later that same year, the contents of this paper were incorporated in a book, "Alternating Currents," by Bedell and Crehore, which long served as a standard text-book, and even to-day is an excellent introduction. The same can be said of Bedell's "Principles of the Transformer," published in 1896.

But to apply the theory, a knowledge of the wave form was necessary, and no instruments existed that could determine the form of an electric wave that lasted 1/20th of a second or less. From 1893 on Dr. Bedell and others devoted themselves to this task. Various mechanical and electrical methods were devised. The most successful of these was the Dudell oscillograph about 1900. This consisted of a very light element suspended in a magnetic field produced by the current to be investigated. This element moves back and forth in tune to the alternations of the field, and makes it possible to photograph the curve of the wave form on a moving film. This instrument is still useful for low frequencies. But however light the suspended element, it still has weight, and its oscillations lag behind those of the field, and above a certain frequency cease altogether. For high frequencies a weightless vibrator was needed. This came with Dr. Bedell's cathode ray oscilloscope in 1927. The vibrator is an electron stream which will follow the most rapid oscillations even up to the ultra-high frequencies now used in radio. Cathode ray oscilloscopes were not new, but they had lacked a reliable time axis. They only produced a figure on the screen from which the wave form could be mathematically deduced. Dr. Bedell's invention remedied this defect. The wave form known, the harmonics present could be determined, and the theory showed how to suppress them or at least to reduce them to harmless dimensions.

The amounts that could be safely allowed were also determined. In 1915, Dr. Bedell as chairman of the subcommittee on wave form of the Standards Committee began setting up wave form standards to make alternating current machinery safe. Penalties were imposed on the different harmonics according to their frequencies, in this way, as Dr. Bedell put it, making the penalty fit the crime.

With these standards, which have been revised from time to time, fireworks have disappeared from the switchboards and elsewhere. The wild waves have been tamed, and no one is now afraid of alternating currents.

THE EXPECTATION OF LIFE

FANTASTIC as it may sound, we are outliving our expectation of life. Statisticians for the Metropolitan Life Insurance Company point out that men and women born in 1876, for example, had an expectation of life when they were born of 41.4 and 44.6 years, respectively, on a statistical basis. But the average length of life for men and women born that year turned out to be 46.3 years

for men and 50.6 years for the women. The figures are for England and Wales, but the principle applies in this country as well. This extra lease on life has been gained because of the advances of science and the standards of living.

The United States to-day has 2,900,000 more potential soldiers, men between 20 to 44 years old, than it would have had if it had not been for these life-saving improvements.

Many a man alive to-day knows that he owes his life to an operation or medical treatment—the sulfa drugs or insulin, for example—which has been developed during his lifetime. Many thousands of others owe their lives more indirectly to the advances of science. Of the 900,000 men and women aged 65 years alive in the United States to-day, 300,000 owe their lives to such advances. If conditions prevailing at their birth had continued, those 300,000 would not be alive.

The term "expectation of life" is not always used in its exact sense, the life insurance statisticians point out. "Strictly speaking," they state, "the expectation of life at any age is the prospective average number of years of life remaining to persons of that age, provided that the death rates at each age remained constant at their prevailing levels. Thus if we say that the expectation of life for a white male 10 years old in 1940 was 57 years, we mean that the members of the large group of boys of age 10 in that year would, on an average, survive 57 years, if the death rates at each age of life remained unchanged as of 1940."

CASES OF POISONING IN WAR PLANTS

THAT tetryl, chemical relative of TNT, is producing thousands of cases of poisoning in war plants, is reported by the *Journal* of the American Medical Association.

As production of explosives for the armed forces goes into high gear, an increasing number of poisoning cases are expected—odd cases of sickness with which the medical profession has been unfamiliar in peace-time practice. Symptoms usually occur after the second or third week of exposure. They usually consist of loss of appetite and nausea, coughing or sneezing, nosebleed, and—most significant of all—a characteristic inflammation of the skin. Anemia is also present in a good many cases. Yellow coloration of the skin of these war workers is not a symptom, but merely a staining of the skin.

Observations made on 1,258 cases by Dr. Leon J. Witkowski, Dr. C. N. Fischer and Howard D. Murdock, of Chicago, reported in the *Journal*, emphasize that the reactions are not only local, but affect the system as well. Of the war plants investigated where tetryl is processed about 23 per cent. of the workers were affected.

Although many workers were found to eventually develop a tolerance to the explosive after a number of weeks, the illness is not to be neglected. Physicians have already devised measures to protect health and avoid lost time in the war effort.

The physicians making the report emphasize the necessity of controlling the tetryl dust found in the plant atmosphere. This may be aided by conducting certain operations in small closed rooms separated from the rest of the plant. Cleanliness, ventilation, and temperature below 72 degrees Fahrenheit, are also important. Dietary measures, which have been recommended by some, consisting of taking milk or vitamin C, do not appear to be of great value to date. Lotions and ointments have been successfully used by physicians to allay the skin inflammation and the anemia is controlled by standard methods of treatment.

Use of great quantities of tetryl in certain defense areas has introduced a new occupational hazard—a challenge that can be met, when symptoms are first noticed, by cooperation of the workers and industrial medicine.

BUTYL RUBBER TIRES

BUTYL rubber tires in actual tests on New Jersey highways have shown a life of 20,000 miles if kept below a maximum of 40 miles an hour, was reported by J. P. Haworth and F. P. Baldwin, of the Esso Laboratories, before the Buffalo meeting of the American Chemical Society.

Some plants for the production of this type of rubber are already in production. Others are under construction. By a year from this fall the total production of butyl rubber will reach an annual rate of 130,000 tons.

Possibilities of "tailor-made" rubber for the different parts of a tire were pointed out. In the average light car tire, weighing about 12 pounds, only about four pounds is in the conspicuous part, the tread. Requirements for tread are different from those of side wall, and these in turn differ from those of carcass and inner tube. Synthetic rubbers can be given properties to suit the uses to which they will be put, which is not possible with natural rubber.

Perbunan, a highly specialized kind of synthetic rubber made of butadiene and acrylonitrile, was described by three other chemists of the Esso Laboratories, R. A. Moll, R. M. Howlett and D. J. Buckley. Acrylonitrile, a derivative of ethylene, comes, like butadiene, from oil and natural gas. One of its ingredients, hydrocyanic acid, can also be manufactured out of natural gas plus nitrogen from the air.

Perbunan's special claim to consideration is its high resistance to oil and gasoline, which makes it well adapted for use in self-sealing tanks for fighter planes, linings for filling-station hose, gaskets for oil pumps, and any other jobs involving exposure to oil.

It is also highly resistant to wear and quite resilient. This would make it an excellent tire rubber; but it is difficult to handle in manufacturing processes, so that its cost is high—somewhere between two and three times that of natural rubber. It should, however, make excellent tread blocks for tanks, a use that does not involve so much hand work as the preparation of tires.—FRANK THONE.

ITEMS

THE volcanic structure of the Galapagos Islands off the coast of Ecuador, now occupied by American troops, provides natural harbors. In spite of its name, Wreck Harbor, on the coast of Indefatigable Island, is said by geologists to be a safe and excellent approach to the shore.

Before the Galapagos acquired vital importance as a Pacific base for protection of the Panama Canal, they had long been an historic spot frequented by zoologists. It was here that Charles Darwin's famous idea occurred to him, like Newton and the apple. Only in Darwin's case, it was the sight of strange, unique forms of plant and animal life—giant turtles and uncouth sea lizards—which crystallized his theories of evolution through natural selection. Sixteenth-century Spanish navigators were so impressed by these giant turtles, often four feet long, that they gave the islands the Spanish name for "tortoise." Since the nearest relative to the Galapagos tortoise is a fossil found in Cuba, geologists believe the islands were once part of Central America, even though they are now 500 miles west of Ecuador, in South America. They are composed of twelve large, and several hundred small, islands, with many volcanoes still actively erupting on their shores.

SMOKELESS powder and synthetic rubber can be made cheaply and abundantly, using alcohol from watery wastes now poured down the sewer. The economics of the method, which by-passes the expensive distillation process, were explained before the Buffalo meeting of the American Chemical Society by Dr. Donald F. Othmer and Dr. R. L. Ratcliffe, of the Polytechnic Institute of Brooklyn. Waste liquors from paper mills and other industrial plants, as well as sawdust, straw, cornstalks and other agricultural wastes, contain sugars capable of being fermented into alcohol. But the solutions are so thin and watery that the fuel needed for distillation is worth more than the alcohol that could be obtained. Key to the riddle is fusel oil. Fusel oil dissolves alcohol but will not mix with water. So this toper's enemy is put to work getting the alcohol out of the watery wastes. Subsequently a chemical divorce between the alcohol and the fusel oil is arranged. A similar use of fusel oil can be made in getting acetone and other valuable industrial solvents out of solutions until now considered too thin to be profitably worked.

HOPE of controlling at least to some extent future influenza epidemics that may add to the horrors of war appears in a report to the American Medical Association by Dr. Joseph Stokes, Jr., and Dr. Werner Henle, of the University of Pennsylvania Medical School. A vaccine protected 43 out of 44 boys who were directly exposed to influenza. They inhaled through aviation oxygen masks a vapor of fluid from hen's eggs that contained a strain of influenza A virus. These germs were freshly isolated from a baby who had died with an overwhelming influenza infection. But only one boy caught the disease. Of 28 unvaccinated boys who breathed this same influenza germ-laden vapor, ten had attacks of influenza. The vaccine that gave such striking protection might not be able to stop an epidemic of influenza, even if it were possible to vaccinate the entire population. The vaccine protects against influenza A but there are other types of influenza that occur in epidemics against which the vaccine could not give protection.